## WATER RESOURCES EVALUATION WATER USE FLOODING Based on median values computed from flood SPRING RIVER NEAR WACO data for Lamine River at Clifton City, Sac [The Missouri River and its alluvial valley are not considered in this evaluation Approximately three-fourths of the 1,300 million gallons of water Water years 1927-70 (Bankful River near Stockton, South Grand River near as they are included in Hydrologic Atlases 372 and 444] stage is 19 feet or about 852 withdrawn each day in west-central Missouri is used for cooling pur-Brownington, Spring River near Waco, and poses by electric power plants. Most of this water is obtained from feet above mean sea level) Shoal Creek above Joplin Selected sources impoundments, however, a significant amount is obtained from the Existing or poten-Missouri River. Only a fraction of the cooling water is consumed and tial problem Alternatives Information needed of information ESTIMATED WITHDRAWALS IN WEST-CENTRAL 11 Number of flood most water used for this purpose is available for reuse. MISSOURI DURING 1969 peaks during The second greatest use of water in the area is for public supplies. Flow of unregulated Plains streams, except for Osage River, generally Streamflow data. U.S.G.S. period that occurred The average per capita water use for towns in the area with popula-(Millions of gallons per day) inadequate during droughts. Flow of Plateau streams north of the | Time-of-travel studies. in indicated month tions greater than 1,000 is 113 gallons per day. In general, towns with Osage River also inadequate. Larger Plateau streams south of the Storage estimates for low-flow augmore industry have a higher per capita water use than do towns where Osage River may provide dependable supplies. most water is used for domestic purposes. Water quality of streams is highly variable. High salinity in Black- | Seepage measurements. Self-supplied industrial water use is concentrated in the Kansas Citywater River at low flows. High bacteriological counts in some | Water-quality data including sedi-Independence area and in the vicinity of Springfield and Joplin. Nustreams. Treatment is required. ment yield, biological, and trace-Electric powerbmerous industrial water users are also located in the vicinity of smaller element data. towns throughout the area. Of particular significance to the development of rural areas and U.S.G.S Springs are few and small on the Osage Plains and most yield highly | Springflow data. small towns, has been the recent growth of public water-supply dismineralized water. Water-quality data. tricts in the area. A total of 48 such districts were either in operation Irrigation\_ More numerous and larger springs in the Plateaus. These springs are Knowledge of recharge areas for Local spring or in the planning stage as of June 1971. used to supply water to fish hatcheries, to augment municipal and Plains and Plateau springs. Although water used for irrigation represents only a small fraction industrial supplies, and to supply domestic and stock water for farms. Hydrologic studies to determine Percent of total\_. of the total water use in the area, use of water for this purpose oc-Springs generally have fairly stable water-quality characteristics but the relationship between streams. curs during the dry summer months and is largely a consumptive aquifers, and springs. flow is variable. use. Irrigation has increased steadily in the southwest since about Includes water pumped from Missouri River and its alluvial valley by Kansas City May be subject to pollution from surface sources. 1964. Barton and Jasper Counties led other counties in the area in irand other users south of the river. rigation during 1970 with estimated irrigation uses of 7.7 and 7.5 mgd. <sup>b</sup>Most water used for this purpose is not consumed and is available for reuse. May be necessary in northwestern part of the area because of low base-Hydrologic data for reservoir and U.S.G.S respectively, during the 10-week irrigation season. Includes water used by public water-supply districts. spillway design for large and | Corps flow characteristics of streams and unsuitable aquifers. May be used to supplement streamflow sources during periods of little Knowledge of geologic, sedimenta- S.C.S APPROXIMATELY 60 PERCENT OF ALL FLOODS OCCUR or zero flow. DURING APRIL TO JUNE. - Floods are least likely to occur dur-Watershed should be protected. tion, and seepage characteristics | Mo.Cons.Comm. Treatment is required. ing November to February; however, they may occur during any Knowledge of chemical and biolog-Thermal stratification may cause water-quality problems. Terrain and soils generally suitable for reservoir construction in Plains | ical changes occurring in imarea; proposed sites in Plateaus should have detailed geologic exam-Alluvial and drift deposits in northern part of area yield 10-1000 gpm | Knowledge of hydraulic character- | Mo.G.S. istics of aquifers for well-field U.S.G.S locally to wells. Alluvial deposits in lower Osage Valley may yield sufficient water to Mo.Div.H wells for irrigation Local well Wells in the larger Pleateau stream valleys may yield adequate water drillers SUMMARY OF MUNICIPAL WATER SUPPLIES FOR TOWNS IN for domestic supplies Alluvial water generally has high iron content, but few analyses avail-WEST-CENTRAL MISSOURI WITH POPULATIONS GREATER THAN 1000 able for wells in Plateau valleys. (From Missouri Division of Health, 1969) Shallow wells are subject to pollution from surface. Wells in rocks of Pennsylvanian age yield sufficient water for domestic Knowledge of hydraulic character- Mo.G.S. supplies (1-3 gpm) in northwestern part of area, but dissolved-solids istics of fresh and saline aquifers. U.S.G.S Potentiometric maps to indicate | Mo.Div.H. content is generally high (>1000 mg/l). Wells in rocks of Mississippian age yield adequate water for domestic regional ground-water movement Local well supplies in southern part of area, but subject to pollution from sur- and recharge and discharge areas. drillers Water-quality data for fresh and Wells in Lower Ordovician and Upper Cambrian rocks yield 25 to 600 saline aquifers. gpm southeast of fresh-water boundary. The dissolved-solids content of water in bedrock aquifers increases toward the northwest from less than 500 mg/l to more than 40,000 Note: These relations are based on natural mg/l. These aquifers may become important sources of water with flow conditions. Due to data limitations, the relations should not be used with future developments in desalinization. Benton . Warsaw\_ combinations of drainage area and slope Camden 1,400 | 3 wells less than 10 square miles and 10 feet Multiple-purpose reservoirs help meet water supply and recreation | Hydrologic data for comprehensive | Corps Headwater per mile, respectively, and the 50-year Cass... 10,000 | Kansas City\_ and (or) river-basin planning. relation should not be used for drainage 3.700 | Big Cr. and Pleasant. Streamflow data for reservoir de- U.S.G.S. main-stem Federal participation generally required. areas less than 50 square miles. Three reservoirs constructed in area by Corps of Engineers. reservoirs sign and operation. Harrison-Geologic data for reservoir and dam Mo.W.R.B Three additional reservoirs authorized for future construction. One watershed project completed by Soil Conservation Service and 13 others in various stages of planning. Sediment-yield data for predicting Springs. Lake of the Ozarks on Osage River constructed by Union Electric sedimentation rates. Precipitation and streamflow data Valuable farmland removed from production in reservoir area. for flood forecasting. Cooper Dade Dallas Thermal stratification may cause water-quality problems. Greenfield. 1,000 | 2 wells Buffalo\_\_ 1,500 2 wells\_\_ Hydrologic data for comprehensive | Corps Levee construc- May be accomplished by local or Federal interests. 1,520 | 2 wells\_ Republic\_ Flood profiles of outstanding floods. Mo.W.R.B Well and Elevation-frequency studies for ad- Local drainage Requires maintenance for effective protection. Levees subject to failure during extreme floods and may increase equate design. Foundation and seepage studies of flood heights for adjacent areas. Channelization alters natural flow regime of stream and may result in increased erosion and higher flood peaks. Destroys natural habitat Jackson\_ Jackson-Independ-Definition of flood-prone areas to Corps Reduces flood damages by regulating use of flood plains. increase public awareness of local Mo.W.R.B. Local cooperation necessary for success. Drainage area of 70 square miles Requires supervision and enforcement. flood hazards. 19,000 | Kansas City Lees Summit VERNON Slope of 10 feet per mile Maximum benefit in urban areas. Historical and design flood profiles Jackson\_ Oak Grove\_ 2.000 | Sni-A-Bar and elevation-frequency studies Peak discharge of floods with recurfor establishing adequately zoned 18,000 | Kansas City rence intervals of 10, 25, and 50 years Connect values of drainage area and slope with a straight line and read: Definition of flood-prone areas to | Corps Reduces flood damages for flood-plain structures. Jasper Ja $Q_{10} = 6,500$ cubic feet per second Advance flood warning necessary for implementation of emergency increase public awareness of local Mo.W.R.B 1.440 | Webb Cit EXPLANATION flood-proofing procedures. $Q_{50} = 10,000$ cubic feet per second Historical and design flood profiles to indicate high-water elevations. Flood insurance | Provides limited financial protection against flood losses in urban com- | Design flood profiles and elevation- | F.I.A., Mo.W.R.B Holden\_ Data from Sandhaus and Skelton, 1968 frequency studies for establishing | Corps, U.S.G.S munities and induces the adoption of land use and control measures to reduce future flood damage. flood insurance rates. Johnson --Warrens-\_ Low-flow characteristics of streams. Mo.W.P.B. Waste-water Required by State water-quality standards. Laclede\_\_\_\_ Lafayette 8,250 4 wells Storage requirements for low-flow E.P.A. Supervision and enforcement necessary. Concordia\_ DISCHARGE OF FLOOD PEAK, IN CUBIC FEET PER SECOND Secondary treatment provided by most towns in area with populations Lafayette. Higgins-Definition of assimilative capacity Mo.G.S. in excess of 1,000. Natural flow of several streams, particularly in the Osage Plains, inof streams. THE MAGNITUDE OF A FLOOD OF A SELECTED FREQUENCY Lafayette\_ Lexington adequate for waste dilution during low-flow periods. Geologic data for lagoon sites. CAN BE ESTIMATED FROM REGIONAL RELATIONS BY A Lafayette-2,480 | 2 Imp Inadequate lagoons and septic tanks pollute streams, springs, and Water-quality monitoring of NOMOGRAPH.—Slope is computed as follows: (a) determine altr Lawrence\_\_ Aurora\_\_ streams, springs, and aquifers. tudes, in feet, from a topographic map at points along the main stem Lawrence\_ which are 10 percent and 85 percent of the total distance from the Hydrologic, geologic, and soils data Mo.W.P.B. proposed site to the basin divide, (b) find the arithmetic difference be Underground Waste-injection wells prohibited by 1971 State law. Diagrams include water furnished to public tween these altitudes and divide by the distance between the two points. 1,180 2 wells. for proposed disposal areas. Mo.G.S. Lawrence\_ Pierce City waste disposal | Land fills, lagoons, and septic tanks contaminate ground-water rewater-supply districts by some municipalities. McDonald\_ Anderson4 sources if inadequately designed, constructed, or operated. Monitoring of water quality and E.P.A. Flood-peak discharges for urbanized basins are generally greater Water use is shown only for that part of each Restoration of contaminated aquifers is expensive and may require movement in receiving forma- U.S.G.S than for natural basins. Generalized flood-frequency estimates for county which lies within the report area. From Missouri Division of Health, 1969 Moniteau -California many years. Water use within the report area in some urban areas in Missouri may be obtained from Gann (1971). counties is less than 0.1 mgd and is not Reclamation of Acid drainage from strip-mined areas may pollute streams and aquifers. Effective and economical methods Mo.W.P.B., E.P.A Morgan \_\_ shown. The diagram for Cass County does Newton\_ strip-mined | Provides recreation areas, enhances esthetic values, and results in more of reclaiming strip-mined areas. Mo.Cons.Comm. not include water use of Belton (0.8 mgd) Newton\_\_ Neosho efficient use of land and water resources. Water-quality monitoring of U.S.G.S EXPLANATION which is obtained from Kansas City Newton\_\_\_ streams and aquifers in mining | Local mining La Monte-MC DONALD Knowledge of effects of fertilizers, Mo.W.P.B., known flood -Reduction of agri- Herbicides and insecticides are toxic to aquatic life. cultural pollu- | Fertilizers and feed lot wastes can pollute streams and aquifers and herbicides, insecticides, and ani- E.P.A. Average recurrence interval, in provide nutrients for excessive plant growth. mal wastes on quality of water Mo.G.S. years, at which river might 50 KILOMETERS overflow banks to heights in-Sediment loads of streams are affected by poor farming practices. in streams, aquifers, impound- U.S.G.S dicated at right Base from U.S. Geological Survey ments, and springs. Univ. of Mo., in cooperation with the state of Missouri, 1:500,000, 1968 Height of water above Saline\_\_ Saline\_\_ Marshall Sediment-yield data for streams. Prevention of sa- | Excessive pumping from consolidated aquifers in vicinity of fresh- | Potentiometric maps to indicate re- | Mo.G.S. Altitude of bankfull line-water en- water boundary may induce encroachment of saline water from the gional ground-water movement U.S.G.S THE SOURCE OF A MUNICIPAL WATER SUPPLY DEPENDS near Kansas City ON THE AVAILABILITY AND QUALITY OF WATER IN THE and recharge areas. Lamine River Webster --Knowledge of hydraulic character-LOCAL AREA.—The Missouri River and its alluvial valley are at Clifton City istics of aquifers. major sources of supply for municipalities located near the river Pumpage data. <sup>1</sup>Imp.-Impoundments(s) Larger towns in the area obtain water from streams or impound-Water-quality monitoring of aqui-<sup>2</sup>Mean of indicated per capita uses is 113 gpd. ments. Smaller towns are normally supplied by wells where possible fers in vicinity of fresh water <sup>3</sup>Population served and average daily use for this town is included in Impoundments are required in the northwest where aquifers contain corresponding figures for source of supply. saline water and streamflows are poorly sustained in dry weather. Largest town in county with municipal supply. Use of Plains streams restricted by low base flows, sluggish velocities, Low-flow characteristics of streams. U.S.G.S. Storage estimates for low-flow aug- Mo.W.P.B. high turbidities, and low dissolved-oxygen content. Larger Plateau streams widely used for float fishing and canoeing. Mo.Cons.Comm. High bacteriological counts may restrict recreational uses of some | Water-quality data. Hydrologic and geologic data for Mo.Cons.Comm. May be combined with flood control and water supply. Approximately 380 lakes, mostly manmade, with surface areas in exdesign of large and small lakes. Sediment-vield data for streams. cess of 5 acres are known to exist in the area. Lake of the Ozarks, Pomme de Terre and Stockton Reservoirs offer | Knowledge of chemical and biolog-Mo.G.S. ical changes occurring in lake S.C.S. water-based recreation facilities. environments. South Grand River Planned develop- Necessary in preventing depletion and pollution of streams, springs, Hydrologic data for predicting the U.S.G.S., Mo.G.S. effects of urbanization on the E.P.A., Corps ment with con- and aquifers in urbanizing areas. SEWAGE TREATMENT sideration of Alteration of natural surface storage and drainage may increase flood water resources of individual Local municiheights and shorten arrival time of flood peak. Present or potential problem areas include (but not limited to) Jackson, | Comprehensive water-resources | Regional studies of present and potential Greene, and Jasper Counties. problem areas. <sup>1</sup>Corps, Corps of Engineers; E.P.A., Environmental Protection Agency; F.I.A., Federal Insurance Administrator: Mo. Cons. Comm., Missouri Conservation Commission; Mo. Div. H., Missouri Division of Health; Mo G.S., Missouri Geological Survey and Water Resources; Mo. W.P.B., Missouri Water Pollution Board; Mo. W.R.B., Missouri Water Resources Board; N.W.S., National Weather Service; S.C.S., Soil Conservation Service; U.S.G.S., U.S. Geological Survey INDEPENDENCE SELECTED REFERENCES See inset River Spring River near Waco Niangua River 0 10 20 30 40 50 MILES 0 10 20 30 40 50 KILOMETERS Abernathy, G. E., 1937, The Cherokee group of southeastern Kansas, Skelton, John, 1966, Low-flow characteristics of Missouri streams: Mis-Base from U.S. Geological Survey souri Geol. 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Searight, W. V., and Palmer, E. J., 1957, Burgner formation, pre-Des-MC DONALD Pub. 1, 303 p. moinesian Pennsylvanian deposit in southwestern Missouri: Am. PUBLIC WATER-SUPPLY DISTRICTS FURNISH DEPENDABLE able from shallow domestic wells and where suburban development is Drainage divide Assoc. Petroleum Geologists Bull., v. 41, no. 9, p. 2127-2131. ESTIMATES OF FLOOD HEIGHTS AT UNGAGED SITES IN per end of the riffle just downstream from the site for which flood-WATER SUPPLIES TO RURAL AREAS AND SMALL TOWNS.— less rapid. Water for many developing areas in the vicinity of Kan-L-0.30 Elk Pineville The location of water-supply districts is related to the availability of sas City, Springfield, and Joplin is obtained from the municipal sup-THE PLAINS CORRESPONDING TO SELECTED FREQUENheight estimates are desired. Add 1 foot to flood-height values for plies. The increasing availability of public water supplies and the CIES CAN BE OBTAINED FROM REGIONAL FLOOD HEIGHTdrainage areas larger than 100 square miles. fresh water and to suburban growth. The low yields and marginal Data furnished by Missouri Water Owing to the higher gradients of Plateau streams, flood heights for water quality of shallow aquifers in Vernon and Barton Counties extension of multilane divided highways may, in time, help to reverse FREQUENCY RELATIONS.—Average standard errors for these Pollution Board and Environmental have resulted in the formation of large water districts supplied by the downward trend in population of several of the counties in the relations range from 21 percent for the 50- and 25-year floods to 35 selected frequencies are generally less than for Plains streams. There-Base from U.S. Geological Survey Protection Agency (formerly Federal percent for the 1.2-year flood. Flood height is defined as the vertical fore, application of the above relations to Plateau streams in the area deep wells in these two counties. Water districts have shown less area. Water Pollution Control Administragrowth in areas where water of suitable quantity and quality is availdistance above the altitude of zero flow or the lowest point at the up-should provide conservative estimates of flood heights. of Missouri, 1:500,000, 1968 Interior-Geological Survey, Reston, Va.-1974 WATER RESOURCES OF WEST-CENTRAL MISSOURI

E. E. Gann, E. J. Harvey, and J. H. Barks
U.S. Geological Survey
and
D. L. Fuller, and D. E. Miller
Missouri Geological Survey and Water Resources